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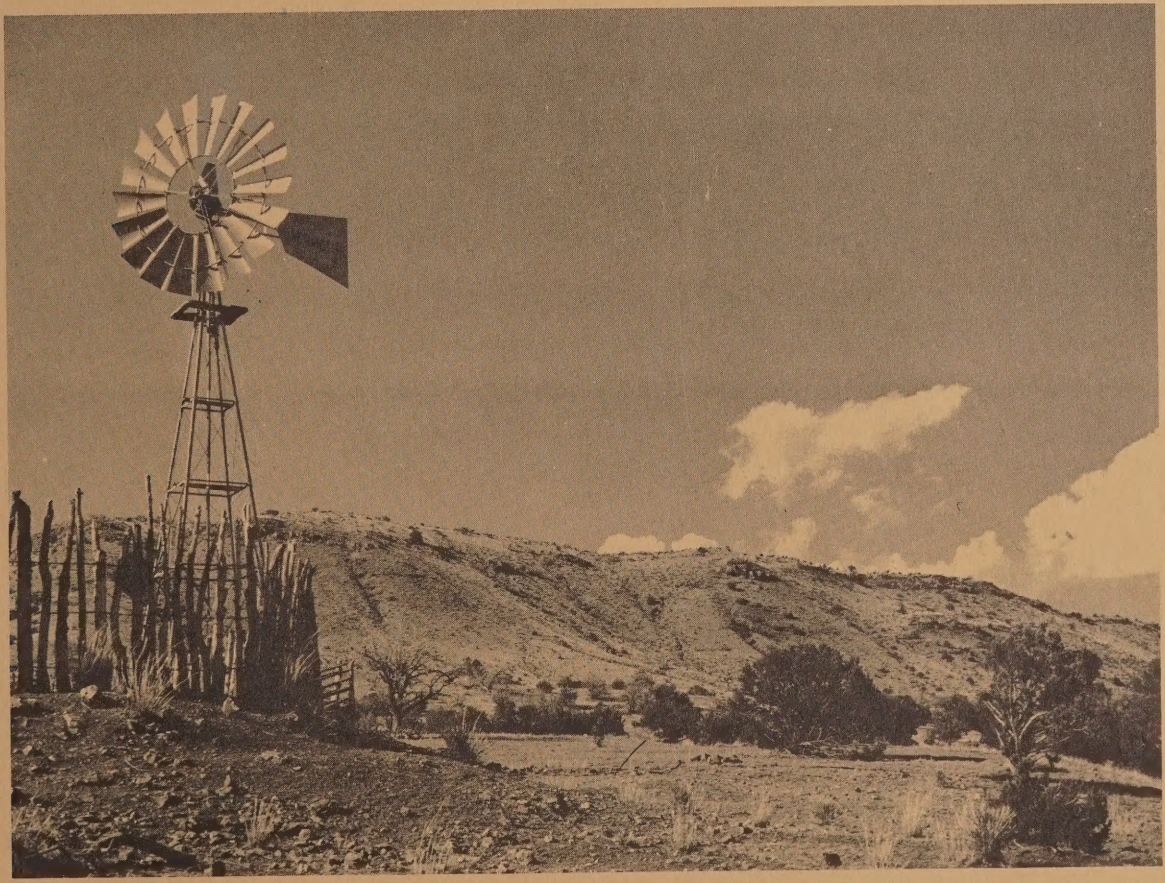
The Geological Survey's Role in Water-Supply Exploration and Development under the Soil and Moisture Conservation Program

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION



OPEN-FILE REPORT

DENVER, COLORADO

JANUARY 1968

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THE GEOLOGICAL SURVEY'S ROLE IN WATER-SUPPLY EXPLORATION AND DEVELOPMENT UNDER THE SOIL AND MOISTURE CONSERVATION PROGRAM

by

R. F. Hadley and others

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Prepared by the Geological Survey as
a reference for other bureaus in the
Department of the Interior

OPEN-FILE REPORT (68-7)

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THE GEOLOGICAL SURVEY'S ROLE IN WATER-SUPPLY EXPLORATION AND DEVELOPMENT UNDER THE SOIL AND MOISTURE CONSERVATION PROGRAM

INTRODUCTION

One of the major activities of the Geological Survey in the Soil and Moisture Conservation Program of the Department of Interior is to provide technical assistance to other bureaus in the development of water supplies on public land under the Department's jurisdiction. This reference has been prepared to promote a better understanding of (1) the scope of assistance offered by the Survey in the development of water supplies, and (2) the kinds of data that should be obtained at sites under development in order to facilitate future investigations.

ORGANIZATION

All phases of the Soil and Moisture Conservation Program in the Geological Survey are under the direction of R. F. Hadley, SMC Program, Water Resources Division, Denver, Colorado, who in turn reports to the Regional Hydrologist, Water Resources Division, Rocky Mountain Region, Denver, Colorado. Water-supply exploration activities done from the Denver office cover the States of Montana, Wyoming, Colorado, New Mexico, and eastern Utah. Water-supply exploration activities done from the Menlo Park office cover the States of Washington, Oregon, Idaho, Nevada, Arizona, California, and western Utah. All inquiries concerning the SMC Program should be addressed to Mr. Hadley. In order to facilitate scheduling it is desired that requests for examinations be submitted at least four months in advance and coordinated through the appropriate state or area office of the land agency. An example of a request for a well site or spring examination is shown on p. 8.

Correspondence should be addressed to:

Chief, SMC Program, U.S. Geological Survey, WRD, Federal Center,
Bldg. 25, Denver, Colorado 80225.

SCOPE OF INVESTIGATIONS

To fully discharge our responsibility in the various aspects of water development under the SMC Program, the Survey conducts several types of investigations. Each has been developed to meet a specific need of the cooperating bureaus consistent with personnel and budget limitations. As these needs and/or limitations vary with time and area, it is our intent to adjust our approach to fit the circumstances. To this end we welcome suggestions for continued revision of our investigating and reporting techniques. A description of the types of investigations currently available together with explanatory notes follows.

Site Examinations

Well sites.--Field examinations are made of specific sites selected by personnel of the Bureau of Land Management, the Bureau of Indian Affairs, or by allottees under Section 4 permits approved by the Bureau of Land Management. Site examinations are necessarily brief and are aimed mainly at evaluating local conditions of ground-water occurrence. The examiner should be accompanied in the field by someone familiar with the site in question, with the specific needs for the water supply, and with all existing sources of water in the vicinity. Results of the examination are reported (see example 2) in the form of a memorandum prepared for transmittal by the Director of the Geological Survey to the Director or Commissioner of the appropriate cooperating bureau. A copy of this memorandum is sent to the field office where the request originated.

Spring developments.--Examinations are made of springs or seeps to determine their probable source and the best method of development. Such examinations should be made during the period of lowest flow and should be preceded by a careful check with local inhabitants to determine the reliability of the spring during periods of extended drought. Reporting procedure is similar to that for well sites.

Reservoir sites.--Because of personnel and budget limitations, examinations are not normally made of reservoir sites. However, sites having unique geologic or hydrologic problems are examined as other work permits. Reporting procedure is similar to that for well sites.

Allotment Examinations

Using techniques similar to those employed in well-site investigations, field studies are made of all or part of an allotment in company with someone familiar with water needs in the allotment. This approach enables selection of the most practical method of water development from the standpoint of both geology and range management. Reporting procedure is similar to that of well-site examinations.

Areal Evaluations

A reconnaissance is made of an allotment or administrative unit within a grazing district or reservation to determine the general prospects for developing water supplies. The area examined may cover as much as several thousand square miles. Areal evaluations provide assistance in land management planning and should be supplemented by subsequent site or allotment examinations. Results are reported in brief outline form similar to that for site examinations (see example 3). If feasible, a map is prepared to show the general conditions of ground-water occurrence.

Areal Studies

As budget and personnel limitations permit, more detailed geohydrologic studies are made of selected areas ranging in size from small administrative units to entire grazing districts or Indian reservations. Areal studies are more comprehensive than areal evaluations and include (1) an inventory of existing water supplies, (2) appropriate geologic mapping where necessary, and (3) preparation of an administrative report for subsequent publication describing pertinent aspects of stock-water development (as an example, see U.S. Geol. Survey Water-Supply Paper 1475-N, Hydrology of stock-water development on the public domain of western Utah).

Examination of Existing Wells in Need of Development

Examinations are made of existing wells where the yield reportedly has diminished and is no longer adequate. Scheduling and reporting procedure is similar to that for site examinations.

Assistance During Drilling Operations

Generally, because of personnel and budget limitations, little or no assistance is provided during well-drilling operations. However, if questions or unforeseen difficulties arise, or if the recommended drilling depth is reached and the yield is inadequate, the appropriate research hydrologist (see p. 2) should be called immediately. Often recommendations for continued drilling or abandonment of the hole can be made without further fieldwork, but if the services of a geologist in the field appear necessary, appropriate arrangements will be made. Services of this nature take precedence over other types of investigations.

DATA COLLECTION

Results of the various types of investigations described depend largely on the availability of accurate data in the areas examined. In areas where there are many springs and operating wells, local conditions of ground-water occurrence often can be predicted with confidence. In areas where little or no data are available, evaluations are necessarily speculative and must be based largely on experience gained elsewhere in similar rock types and terrain. Most water-supply explorations under the Soil and Moisture Conservation Program are in areas where very little data are available. It is especially important, therefore, to collect pertinent information at all wells drilled on lands administered by the Department so as to facilitate future investigations in the same general area or in other areas having similar geologic and hydrologic conditions. Following is a description of the kinds of data that should be collected together with explanatory notes and examples of completed well record and well log forms. Supplies of these forms and bags for drilling samples will be furnished by the Geological Survey (see p. 2) on request.

Record of Well

The driller, assisted by bureau personnel, should provide a record of the well by completing the front side of Form 9-1474. A copy of this form (see example 4) has been prepared as a guide. Notes have been appended to explain certain entries and methods for obtaining the data requested.

Log of Well

The driller should carefully and accurately keep a complete well log on the reverse side of Form 9-1474 continued, if necessary, on Form 9-1475. Entries (see example 5) should show the depth below land surface, thickness, type, color, grain size, and drilling characteristics of rocks penetrated, and particularly the presence or absence of water. Entries should be made at each apparent change in materials with intervals between entries not to exceed ten (10) feet. The log should be kept up-to-date with the progress of drilling and should be available for examination at any time during the drilling operation.

Drilling Samples

A sample of cuttings from the well should be taken by the driller at each apparent change in the character of the rocks penetrated or after each drilling operation or "run" when using a percussion drill. Intervals between samples should never exceed ten (10) feet as changes in grain size or mineral content may occur that are not apparent to the driller. Each sample should be carefully washed and placed immediately in a cloth bag, filling the bag about half full. The label attached to the bag should show, in pencil or insoluble ink, the name of the well, the location, the number of the sample, and the depth interval sampled. Suggested methods of sample collection for the types of drilling rigs most commonly used are as follows.

Percussion (cable tool, churn, spudder) drills.--Representative samples or rocks penetrated by this type of drill are easily obtained from the bailer as the hole is cleaned after each drilling operation or "run." Each sample should be collected from the first bailer emptied after a run (usually 3 to 5 feet) and, after washing, placed in a properly labeled bag.

Hydraulic-rotary drills.--Representative samples of rocks penetrated by hydraulic-rotary drills are somewhat more difficult to obtain than with other types of drills. Cuttings are carried to the surface by circulating a mud that consists largely of fine-grained materials added by the driller or obtained from cuttings higher in the hole. These materials may obscure the character of the rocks being drilled. Another problem is correlating samples with drilling depth, especially in deep wells, because of lag time; i.e., the time that it takes a particle dislodged by the bit to reach the surface. Despite these difficulties, however, representative samples usually can be obtained by means of a sampling device installed in the return flow ditch between the hole and the mud pit. Many types of sampling devices are currently in use, most of which have been fabricated by drillers to suit their individual preferences. The simplest and perhaps most common type of sampler is essentially an open end box or trough with a removable baffle. With the baffle in place cuttings accumulate in the box behind the baffle. These cuttings can be examined, washed, and placed in properly labeled bags at appropriate intervals. After a sample is taken, the baffle is removed and the remainder of the cuttings flushed to the mud pit. The baffle is then replaced to repeat the sampling procedure. This method provides a composite sample of the rocks penetrated in the sampling interval. It is especially important, therefore, that a sample be taken at each change in the character of the rocks being drilled, otherwise a composite sample may be more misleading than helpful. Sampling can be improved by having the driller stop drilling and circulate mud at each formation change. Circulation time should equal lag time for a good sample. The interval between samples should not exceed ten (10) feet. Correction for lag time must be made in labeling the sample.

For example, if the drilling rate is 20 feet per hour at a depth of 400 feet, the lag time involved with a typical drill rig would be 10 to 15 minutes during which time the drill penetrates an additional 3 to 5 feet.

A fine- to medium-meshed screen may be held momentarily in the mud stream at the point of discharge from the hole to obtain spot samples so as to determine changes in the character of the rocks being drilled.

Air-rotary drills.--Representative samples of rocks penetrated by air-rotary drills are easily obtained at the point where cuttings are discharged from the rotating blowout preventer that caps the hole during drilling operations. Samples are generally dry and subject to less mixing or contamination than with other drilling methods. Thus, changes in the character of the rocks penetrated are readily apparent. Samples should be taken at each apparent change of materials with intervals between samples not to exceed ten (10) feet. This sampling method applies only when cuttings are removed by air (see discussion of air-rotary drills, p. 14).

Data from Miscellaneous Sources

The ultimate objective of the Geological Survey is to complete areal studies and to publish reports regarding water supplies on lands administered by the Department under the SMC Program. To this end the following kinds of data should be collected when available and furnished to the appropriate research hydrologist (see p. 2).

Wells not drilled under government contract or Section 4 permit.--Obtain a copy of the driller's log, if available, and complete as thoroughly as possible Form 9-1474. Especially important are the location and total depth of the well; the depth to the static water level; the yield; the character, depth, and thickness of the aquifer; and the casing record, which should include the type and spacing of all perforations.

Springs.--Obtain whatever information is available. Data should include the location, the amount and seasonal variation of the yield, the permanency of the flow during periods of extended drought, and the type of development, if any.

Geophysical and mineral prospecting holes.--If possible obtain a copy of the driller's record which should show the date drilled, the location and total depth of the hole, a log of the rocks penetrated, and the presence or absence of water.

Oil wells.--Obtain any pertinent data available. Because of the heavy drilling muds utilized in this type of drilling, however, the presence of water in beds penetrated at depths of less than a thousand feet is seldom detected or noted. Copies of logs of wells drilled on the public lands are on file and can be obtained by the Geological Survey.

EXAMPLE 1

WELL-SITE OR SPRING EXAMINATION REQUEST

District[1] ______________, State ________________

Fill in as many spaces as you conveniently can. The more advance information available for office study the better and more efficient job we can do when we visit the site. Send this form directly to the appropriate research hydrologist.

1. Name of site:[2] ____.

2. Location:[3] T. ______ N/S., R. ______ E/W., ______ ¼ ______ ¼ sec. ______________
____.

3. Contact man:[4] ______________________ at ______________________.

4. Topographic map (indicate whether 7½', 15', or AMS quadrangle):[5]
____.

5. Planned use:[6] ____.

6. Yield: minimum acceptable __________ gpm; desired ________________ gpm.

7. Approximate date examination desired:[7] ______________________________.

8. For contract preparation by ____.
(date)

9. Nearby wells:[8]

	Well 1	Well 2	Well 3
a. Location			
b. Depth			
c. Use			
d. Water level			
e. Yield (gpm)			
f. Available for tests or measurement			

g. Additional information ____
____.

10. Nearby springs:

a. Location			
b. Yield (gpm)			
c. Meas., est., rept.			
d. Use			

11. Geologic and topographic environment[9] ______________________________
____
____.

12. Remarks:[10] ____
____.

Instructions for preparing Well-Site or Spring Examination Request

1/ Bureau of Land Management District number and headquarters.

2/ All sites should be named by personnel of the cooperating bureau prior to requesting the examination. Preferably, the name should be after a local geographic feature rather than an allottee or other person to avoid duplication of site names.

3/ Show location as accurately as possible using official rectangular division descriptions. Additionally, give position with respect to local features (e.g., about 1,500 feet NW of Jones No. 3 well). In areas where public land surveys have not been made, sites should be located with respect to prominent geographic features.

4/ The person who will accompany the Survey Hydrologist at the time of the field examination. Show his office location and telephone number.

5/ Also indicate other maps, if any, that are available.

6/ Stock, recreation, construction, other (describe).

7/ When requests from all Grazing Districts are received, a tentative field schedule is prepared. A final examination date is confirmed by direct contact with each district office.

8/ Location--use township, range, and section.
Water level--in feet below land surface.
Available for tests or measurements--Can a steel tape or sounding line be lowered into the well? Does the owner object?

9/ Give all readily available information such as type of rock, major structure, distance from major streams, location with respect to mountains, basins, plateaus, etc.

10/ Any other information. Use back of form if necessary.

EXAMPLE 2

Typical report of results of a well-site examination
with notes appended to explain and qualify entries.

Memorandum

To: Director, Bureau of Land Management

From: Director, Geological Survey

Subject: INFORMATION--Examination of well sites in Bureau of Land Management Districts 2 and 3, Miles City, Montana

In response to a request from your Miles City office, N. J. King and W. R. Osterkamp of the Geological Survey completed the subject examinations during the period July 16-20, 1962. They were accompanied in the field by Joe Bagley and Larry M. White of the Bureau of Land Management.

As a result of this investigation, the following information is being furnished to your Miles City office.

1/ Huckins Wash Site

2/ Location.--SW¼NW¼ sec. 25, T. 7 S., R. 49 E.; about 50 feet east of a geophysical shot hole about midway between the road and Huckins Wash. The exact location is not critical.

3/ Site selected by.--Joe Bagley, BLM, and F. F. Huckins, Allottee.

4/ Altitude of land surface.--3,545 feet.

5/ Inferred aquifer.--Sandstone beds or lenses in the Tongue River Member of the Fort Union Formation.

6/ Estimated drilling depth.--250 to 350 feet. Appropriate adjustment should be made if drilling is at a location higher or lower than that of the site described above.

7/ Estimated depth to static water level.--200 to 300 feet.

8/ Estimated yield.--5 to 10 gpm.

9/ Estimated quality of water.--Good

10/ Drilling and casing recommendations.--The well should be drilled with a percussion (cable-tool) rig and cased its entire depth with standard 6-inch casing. If possible, the casing should be slot perforated for each water-yielding bed before insertion of the casing in the well. Slots should be about 1/8 inch wide, 8 inches long, and spaced at 90° angles around the circumference of the casing. Each group of 4 slots should be separated from the adjacent group by a vertical distance of 2-3 inches and offset by 45° so as to retain casing strength.

11/ Evaluation.--The general area under consideration lies on the moderately dissected upland about 2 miles east of the Powder River and is underlain by interbedded sandstone and shale of the Fort Union Formation. The successful completion of a well in this area generally depends on penetrating a permeable sandstone bed below the local level of saturation. Not uncommonly, however, perched water is found at relatively shallow depth in discontinuous sandstone lenses that hold water because they pinch out laterally and are not exposed in the valley side slopes.

Two wells have been drilled in the proximity of the Huckins Wash Site. The Huckins well about a mile northwest of the site was drilled to a depth of 253 feet and obtained water from a sandstone bed below the level of the nearby Powder River. The static water level in this well corresponds closely to the river level. Conversely, the Bunk-Huckins No. 1 well about a mile northeast of the site obtains water from a sandstone lens at a depth of 46 to 50 feet. The static water level in this well stands almost a hundred feet higher than river level.

Hence, it follows that a suitable supply of stock water may be obtained from a sandstone lens at comparatively shallow depth at the proposed site, but drilling should not be undertaken on this premise. Very likely it will be necessary to drill somewhat below the level of the Powder River at its nearest point, a depth of about 260 feet, to successfully complete a well at this location. The maximum depth to an aquifer should not greatly exceed 350 feet.

Notes explaining and qualifying entries in Example 2.

1/ All sites should be named by personnel of the cooperating bureau prior to requesting the examination. Preferably, the name should be after a local geographic feature rather than an allottee or other person to avoid duplication of site names.

2/ The site should be accurately located in the field prior to the time of the examination using official rectangular subdivisions of the public lands. In areas such as land grants where public land surveys have not been made, sites should be located with respect to some prominent geographic feature. The location is confirmed at the time of the examination and supplemented with a word description. In level terrain unless otherwise noted, the exact location of the site within the designated area (usually 40 acres) is not critical and should be decided by convenience. In rolling or dissected terrain, however, appropriate adjustment of the estimated drilling depth, etc., must be made if drilling is undertaken at a point higher or lower than the specific location described.

3/ Provides a record of person(s) who selected and located the site in the field. Geological Survey personnel are not listed unless they actually assisted in selecting the site.

4/ The altitude of the land surface is determined from topographic maps and/or corrected altimeter measurements and usually is correct to ± 20 feet.

5/ Lists the name and general character of formation(s) expected to yield water to the well.

6/ Gives the best estimate from available data as to the probable range of depth within which the required yield of water may be obtained. The estimate is based on the inferred level of saturation in the proximity of the site and the depth below this level at which a permeable bed should be reached.

Many formations are comprised largely of impermeable shale, but contain sandstone beds and lenses, the occurrence of which are locally unpredictable. In formations such as these water may be found "perched" in isolated sandstone lenses at less than the estimated depth. Conversely, it may be necessary to drill somewhat more than the estimated depth to penetrate a permeable sandstone. Estimates for individual wells, therefore, may be considerably in error, but experience shows that the total footage for several wells drilled on the same contract into formations of this type generally falls within the range estimated.

7/ Affords an indication of the minimum pumping lift that might be expected. However, it should be stressed that the actual pumping lift depends on the pumping rate in relation to the yield. In wells of low yield the pumping lift may approach the full depth of the well.

8/ Inferred from existing wells or aquifer characteristics. Estimates may be considerably in error.

9/ Water quality for livestock use depends on both concentration and kinds of dissolved solids present in the water. The concentration of total dissolved solids in the sample affords an indication of the suitability of the water for livestock use. An approximation of the concentration of total dissolved solids can be determined in the field by measuring the electrical conductivity of selected water samples. The particular elements and ions in the water can modify these classifications. The quality of the water is then classified as follows.

Very good	0 - 1,000 parts per million
Good	1,000 - 2,000
Fair	2,000 - 3,500
Poor	3,500 - 6,500
Unsuitable	more than 6,500

Standards for drinking water for human use are given in "Drinking Water Standards, 1962," Publication No. 956, U.S. Public Health Service.

These standards are considered when estimating the anticipated quality of water to be developed for human use. It should be noted that U.S.P.H.S. standards contain both recommended limits and mandatory limits for various chemical constituents. In no case may water be supplied for public use that exceeds the mandatory limits.

In all cases the water must meet state and local requirements for public use.

10/ Specific recommendations are given that will enable the most economical maintenance-free development of the required water supply at the site in question. The type of drilling rig recommended depends on the character and water-bearing properties of the rocks to be penetrated. Principal advantages and disadvantages of commonly used drilling rigs are as follows.

Percussion (cable tool, churn, spudder) drill.---Essentially an elongate weight consisting of a drill stem with a sharpened bit at the lower end is suspended from a cable over a mast. These tools are alternately raised and dropped in the hole by a drilling arm connected to an eccentric cam. Water is added to the hole and drilling continues until a viscous mud is formed and the tools no longer fall freely (generally a drilling depth of 2 to 5 feet). The tools are then hoisted from the hole and the cuttings are removed with a bailer. New water is added and the cycle is repeated. Although progress is relatively slow, the percussion rig is capable of drilling a wide-range of materials from unconsolidated alluvium and boulders to fresh granite or basalt. Removal of the cuttings at frequent intervals prevents the sealing off of small yield aquifers, and in effect is a short bailing test. Therefore, it is apparent when an aquifer has been penetrated. This method is considered best for developing small amounts of water from formations in which the position of the water-bearing zone cannot be accurately predicted.

Hydraulic rotary drill.--Drills of this type rotate a bit attached to a drill pipe. Lengths of drill pipe are added as the hole is deepened. Cuttings are removed from the hole by circulating a drilling fluid (generally mud) down the hollow drill pipe, through openings in the bit, and then up the outside of the drill pipe to the surface. Rigs of this type can penetrate alluvium and soft sedimentary beds quite rapidly, but have great difficulty in boulders and in hard rocks. Probably the greatest disadvantage of the hydraulic-rotary drill is that it is not possible to detect a small yield of water while drilling. To test for water, drilling must be stopped and the mud removed from the hole. Moreover, it is likely that the permeability of the aquifer and hence its yield will be temporarily, and in some cases permanently, reduced. For these reasons, the hydraulic rotary drill is recommended only in areas where water is to be obtained from well-defined aquifers, the depth and water-bearing characteristics of which are known. It is especially suitable for drilling deep, small diameter wells that are expected to flow at the land surface.

Air-rotary drill.--Operation is essentially the same as for mud-rotary drills except that cuttings are removed from the hole by circulating air rather than a liquid. Thus, an air compressor substitutes for the mud pump on the drilling machine. (Most air-rotary rigs have both an air compressor and a pump and can be used for either air-rotary or mud-rotary drilling.) Small flows of water can be detected readily as no liquid is used during drilling. Sampling and logging procedures are greatly simplified (see p. 6), and changes in the character of the rocks being drilled are more readily apparent than with drilling methods utilizing a mud. The air rotary is especially suitable for drilling small diameter holes in sandstone, limestone, and similar rocks, the fragments of which do not tend to stick together. The air rotary has difficulty drilling unconsolidated material or bentonitic shale, the fragments of which tend to stick together and ball up on the bit or stick to the sides of the hole. Most of the shale formations in the western states contain montmorillonite (bentonitic) clays that ball when wet. Below the "balling level" cuttings must be removed by a liquid and the operation becomes "mud-rotary" rather than "air-rotary" with all the inherent disadvantages. Therefore, specifications that permit the air-rotary method of drilling for low yield water wells in unproven areas should prohibit the use of a drilling mud. In the event that the yield is inadequate and drilling cannot be continued by the air-rotary method, the contractor should be required to complete the well with a percussion drill.

Air percussion drill.--This method uses a pneumatically actuated hammer attached to standard drill pipe. This downhole hammer is rotated slowly while the tungsten-carbide bit shatters the rock by impact. The cuttings are blown out of the hole by air. The air percussion drill is best suited to drilling granite, basalt, quartzite, chert, and similar rocks that are difficult or impossible to penetrate by other methods.

Driven wells.--Where the ground water occurs near the surface in unconsolidated materials, a driven well can often be installed at very little expense. Where the water table is within 15 feet of the surface a well can consist of a length of 1 1/4 inch pipe with a drive point on the bottom and a pitcher pump at the top. Where freezing is a problem and/or the water table is over 15 feet below the surface the pump cylinder will need to be placed underground, either in a pit or in a cased, augered hole.

Well points are available in sizes from 1 to 4 inches and in lengths from 2 to 10 feet. The smaller sizes can usually be installed by hand, however, the larger sizes will usually require some sort of mechanical driving mechanism. Yields of many hundreds of gallons per minute are possible from this type of well.

Further information on the installation of driven wells may be obtained from the Geological Survey or from books on well drilling.

11/ Provides a statement of the prospects of obtaining a suitable supply of water at the site together with a brief summary of the basis for the preceding estimates and recommendations. The purpose of the evaluation is to summarize available information and interpretations so that personnel of the cooperating bureau can decide whether local water needs justify the expense and degree of risk involved. This approach, in which drilling is neither recommended nor rejected, recognizes the role of economy and management in water-supply development.

EXAMPLE 3

Typical report of results of an area evaluation

Memorandum

To: Director, Bureau of Land Management

From: Director, Geological Survey

Subject: INFORMATION--Prospects for stock-water development in the Seven Lakes Unit, Bureau of Land Management District 3, Rawlins, Wyoming

In response to a request from your Rawlins District office, C. E. Sloan of the Geological Survey made a reconnaissance to evaluate the general prospects for stock-water development in the Seven Lakes Unit. The fieldwork was completed during the period August 20-22, 1962.

As a result of this study the following information is being furnished to the Rawlins office.

Seven Lakes Unit

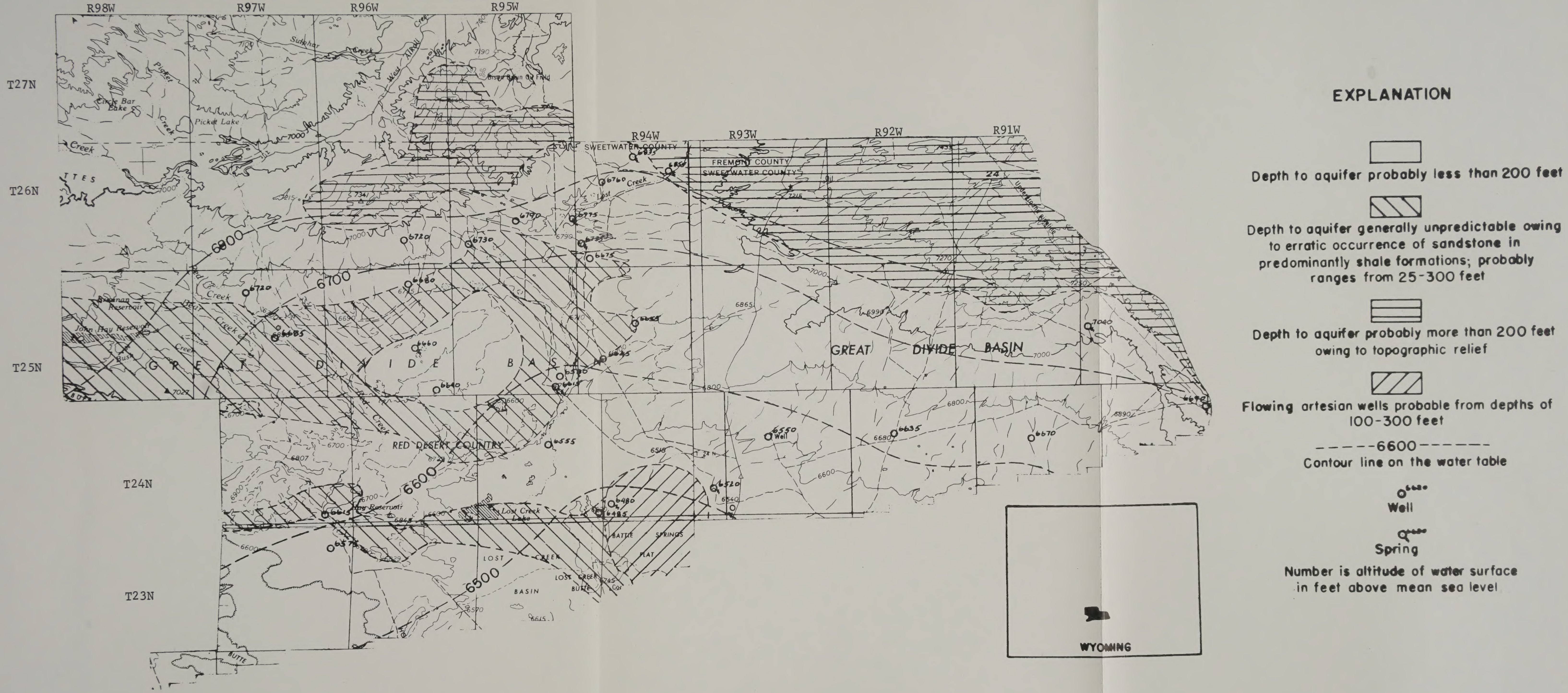
Location and description of the area.--The Seven Lakes Unit is a community allotment of about 1,080 square miles in the northern part of the Great Divide Basin. It is in the northeastern part of Sweetwater County and includes all or parts of Tps. 23-27 N., Rs. 90-98 W.

Topography.--The altitude ranges from 6,475 feet on Battle Springs Flat in the south-central part of the area to about 8,000 feet on Lost Soldier Divide in the northeastern part of the area. Local relief throughout most of the area seldom exceeds 100 feet except along Lost Soldier Divide where relief exceeds 500 feet.

Inferred aquifers.--Alluvium in the larger stream valleys; dune and lacustrine deposits in the dry lake basins; sandstone and conglomerate in the sedimentary bedrock formations.

Estimated drilling depth.--20 to 40 feet in the unconsolidated surficial deposits in the larger stream valleys and in most of the small closed basins; 50 to 500 feet in the sedimentary bedrock formations. Depth to water is generally greatest on ridges and interstream divides and is relatively shallow in areas of low relief. An exception to this generalization may occur in the southwestern part of the area where, despite low relief, comparatively deep drilling may be necessary owing to the lack of permeability in bedrock formations of lacustrine origin.

Estimated depth to static water level.--No artesian rise will occur in wells that obtain water from the unconsolidated surficial deposits, whereas some artesian rise can be expected from most of the wells that penetrate bedrock. The depth to the static water level generally will be less than 100 feet and seldom will exceed 200 feet. Flowing wells can be expected on or near Battle Springs Flat in the south-central part of the area at drilling depths less than 300 feet.


R98W
R97W
R96W
R95W
R94W
R93W
R92W
R91W
T27N
T26N
T25N
T24N
T23N
SWEETWATER COUNTY
FREMONT COUNTY
SWEETWATER COUNTY
Sulphur Creek
Picket Lake
Circle Bar Lake
Brennan Reservoir
John Hay Reservoir
GREAT DIVIDE BASIN
RED DESERT COUNTRY
Lost Creek Lake
BATTLE SPRINGS FLAT
LOST CREEK BASIN
LOST CREEK BUTTE
6800
6700
6600
6500
WYOMING
EXPLANATION
Depth to aquifer probably less than 200 feet
Depth to aquifer generally unpredictable owing to erratic occurrence of sandstone in predominantly shale formations; probably ranges from 25-300 feet
Depth to aquifer probably more than 200 feet owing to topographic relief
Flowing artesian wells probable from depths of 100-300 feet
-----6600------
Contour line on the water table
Well
Spring
Number is altitude of water surface in feet above mean sea level

Inferred conditions of ground-water occurrence in the Seven Lakes Unit, Wyoming

Estimated yield.--5 to 50 gpm; yields will range widely depending on the local thickness and permeability of the aquifer. Yields will probably be highest from the Battle Springs Formation in the eastern half of the area and lowest from the various tongues of the Green River Formation in the western part of the area.

Estimated quality of water.--Water from the unconsolidated surficial deposits and the Battle Springs and Wasatch Formations will be good to excellent. Water from the Green River Formation will be poor to fair, but should be suitable for watering livestock. In general the quality of water becomes poorer from northeast to southwest.

Drilling and casing recommendations.--Wells should be drilled with a percussion (cable-tool) rig and cased their entire depth with 6-inch standard I.D. black steel pipe. If possible, the casing should be slot-perforated for each water-yielding bed before installation in the well. Slots should be about 1/8 inch wide, 8 inches long, and spaced at 90° angles around the circumference of the casing. Each group of 4 slots should be separated from the adjacent group by a vertical distance of 2-3 inches and offset by 45° so as to retain casing strength.

Evaluation.--Inferred conditions of ground-water occurrence in the general area under consideration are depicted on the accompanying map. Flowing artesian wells can be obtained at depths of 100 to 300 feet on Battle Springs Flat, the lowest depression in the area. The quality of water and yield from most aquifers underlying the area should be suitable for livestock needs.

References.--

Masursky, Harold, 1962, Uranium-bearing coal in the eastern part of the Red Desert area, Wyoming: U.S. Geol. Survey Bull. 1099-B, p. B 1-B 152.

Pipiringos, G. N., 1961, Uranium-bearing coal in the central part of the Great Divide Basin: U.S. Geol. Survey Bull. 1090-A, p. A 1-A 104.

Sheridan, D. M., Maxwell, C. H., and Collier, J. T., 1961, Geology of the Lost Creek schroeckingerite deposits, Sweetwater County, Wyoming: U.S. Geol. Survey Bull. 1087-J, p. 391-478.

Form 9–1474
(Aug. 1961)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

RECORD OF WELL

T. 13 N., R. 84 W.
Sec. 17 SW ¼ NE ¼
State Colorado
County Gunnison

EXAMPLE 4

1. **Name of well:** 1/ Red Butte Well
2. **Name of site:** 2/ Red Butte Site
Site selected by 3/Charles E. Sloan, Geologist, USGS Date March 30, 19 62
3. **Agency or owner:** BLM (District C-3) Address Montrose, Colorado
4. **Driller:** 4/David L. Johnson Address 1423 Maple Road, Gunnison, Colo.
5. **Type of drilling rig used:** 5/Percussion (cable tool) drill
6. **Date well started:** June 14, 19 62 Completed June 21, 19 62
7. **Topographic setting:** (In valley, on hill, etc.) On top of Red Butte near the south end. Well is about 1 mile north of Willow Creek and 100 feet higher in altitude.
8. **Altitude of land surface:** 6/ 3,985 ft. Det. by Aneroid altimeter (From USGS report)
9. **Total depth:** 129.5 ft. below ☒ Land surface ☐ Top of casing
10. **Aquifer(s) and depths:** 7/Sandstone 94 - 99 feet; shale 100 - 110 feet (water cased out); sandstone and conglomerate (gravel) 117 - 124.5 feet.
11. **Static water level:** 8/ 93.2 ft. below ☐ Land surface ☒ Top of casing
12. **Shut-in pressure:** (Flowing well) 9/ psi Det. by
13. **Yield:** 10/ 10 gpm after 2 hrs. ☐ Pumping ☒ Bailing ☐ Flowing
14. **Drawdown:** 11/ 31 ft. after 2 hrs. discharging at 10 gpm
12 ft. after 2 hrs. discharging at 5 gpm
15. **Quality of water:** Color Clear Taste Slightly salty
Odor Slight sulfur smell Hardness Moderately hard
16. **Casing:** Distance top ☒ above ☐ below land surface 1.6 ft.
Type Standard black Diam. 6 in. Wt. 18.97/ft. Depth + 1.6 ft. to 94.0 ft.
Type do Diam. 5 in. Wt. 14.62/ft. Depth 91.0 ft. to 129.5 ft.
17. **Perforations:** Type Slots cut by torch Size 1/8" x 8" with 4 slots around pipe
Spacing Slots spaced at 90° angles. Each group of 4 slots offset from next by 45° angle and 3" Depth 94 ft. to 99 ft.
Depth 117 ft. to 124.5 ft.
18. **Pump:** Type 2" cylinder & Jensen Jack Capacity 6 gpm Power Gasoline engine
19. **Record by:** 12/D.L. Johnson (Driller) & J.R. Spade (BLM) Date June 30 196
20. **Remarks:** 13/Rubber packers set at 99 feet and 111 feet to seal out poor quality water from shale at depth of 100 - 110 feet. Well equipped with 1,000 gallon storage tank, troughs, and 6' x 6' shelter house for pump.

Notes explaining entries in Example 4 (Record of Well, Form 9-1474).

1/ Preferably, the well should be named after a local geographic feature rather than an allottee or other person to avoid duplication of names.

2/ Show the name of the site examined by personnel from the Geological Survey. Leave blank if a site examination was not made at or near the location drilled.

3/ Show the name of the person(s) who selected the site (see Example 1, note 2/, p. 9).

4/ Enter the name of the drilling contractor. The name of the driller, if different from the contractor, should be added in parentheses.

5/ For discussion of main types of drills see Example 1, note 10/, p. 11.

6/ From USGS report. If the well was not drilled at the site examined, the measured or estimated altitude of the site drilled should be shown together with the method of determination.

7/ Report all water-yielding beds or zones--not just the principal aquifer(s).

8/ The depth to the static water level should be measured after the water level has reached equilibrium following casing, cleaning, and testing of the well. Preferably, the well should be allowed to stand overnight before measuring, but in any event the depth entered here should be measured not less than four (4) hours after any withdrawal of water. The top of the casing should be used as the reference point unless the height of the casing above the ground is to be modified or the casing is to be removed and the hole abandoned.

9/ Should be completed only for wells that flow at the land surface. High shut-in pressures are most easily measured with a pressure gage calibrated in pounds per square inch or in feet of water. Low shut-in pressures can be measured with a pressure gage or by elevating the discharge point to where the well no longer flows. The vertical distance in feet from the top of the casing to the static water level in the riser pipe, garden hose, etc., used to elevate the discharge point represents the shut-in pressure in feet of water.

10/ The yield in gallons per minute should be measured after the well has been cased and properly cleaned. To determine the yield, the well should be bailed or pumped at the maximum rate practical with available equipment. The test should be continued for at least one (1) hour after a relatively constant bailing or pumping water level has been established to make sure that water is not being obtained from storage resulting from irregularities in the diameter of the drill hole. The best indication of the maximum sustained yield of the well is obtained when the water level has been lowered to near the bottom of the hole.

11/ Drawdown is the distance in feet between the static water level and a stabilized bailing or pumping level when water is withdrawn from the well at a constant rate. The first line of Item 14 (Drawdown) should show the amount of drawdown when water is withdrawn from the well at the rate shown in Item 13 (Yield). The second line of Item 14 should show the amount of drawdown when water is withdrawn at approximately one-half the rate shown in Item 13. Both tests must be continued until the water level stabilizes for the rate of pumping or bailing used. It is not necessary to allow the water level to return to the static level between tests.

Data obtained from drawdown tests enables selection of (1) the proper size (capacity) pump; (2) the pumping level and proper pump setting for a given pumping rate; and (3) the approximate maximum sustained yield of the well in the event that this data could not be measured directly by a bailing test. Drawdown tests also provide a record of the performance of the well at the time of completion. Without this information, it is difficult to determine the need for, or effectiveness of subsequent well rehabilitation.

12/ If possible, the record should be completed by the driller assisted by personnel of the cooperating bureau.

13/ Indicate details of well completion such as the use of cement, rubber packers, etc., to prevent leakage or seal out poor quality water; the use of explosives or chemicals and dry ice to increase the yield; gravel packing; storage and watering facilities; platform; pump house; etc.

Form 9–1475
(Aug. 1961)

☒ Driller's log
☐ Sample log

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

LOG OF WELL

EXAMPLE 5

State Colorado County Gunnison
Location SW ¼ NE ¼ sec. 17 T. 13 N., R. 84 W.
Name of well Red Butte

Depth (feet)		Cuttings sample number	Description of materials drilled			Water yield (gpm)	Remarks (Quality of water, ease of drilling, caving, loss of drilling fluid, etc.)
From–	To–		Type of rock	Color	Other characteristics (Grain size, hardness, etc.)		
0	6	1	Soil	Brown	Surface material	None	
6	10	2	Shale	Black	Soft, clayey	do	Drills very easily.
10	20	3	Sandstone	Red	Medium to coarse grained	do	do; losing water.
20	24	4	do	do	do	do	do
24	30	5	Shale	Dark gray	Soft, Contains shells	do	Drilling sticky, some caving.
30	37	6	do	do	Soft, some thin coal seams	do	do
37	42	7	Coal	Black	Very soft and shaley	do	Drills very easily.
42	50	8	Shale	Dark brown	Sandy, harder than shale above	do	Losing some water.
50	60	9	do	do	do, with some limestone	do	Slower drilling.
60	70	10	Limestone	Light gray	Hard with some shale seams	do	Drills much harder than 50 to 60 feet.
70	76	11	Shale	do	Sandy, medium hard	do	Some caving.
76	80	12	Sandstone	White	Medium grained, very soft	do	Losing water rapidly, hole caving.
80	90	13	do	White to gray	do, brown concretions	do	Better cemented than above.
90	99	14	do	do	do	3	Water at 94 to 99 feet; water hard, salty.
99	100	15	Shale	Grayish brown	Soft, sticky	None	Blocky, some caving; run 6" casing to 94'.
100	110	16	do	do	do	1	Water very bad, strong sulfur odor.
110	117	17	do	Dark gray	Blocky, silty	None	Drills easily.
117	122	18	Sandstone	Buff to yellow	Coarse gravel in fine sand	2	Drilling difficult.
122	124.5	19	Gravel	Buff to brown	Coarse, sandy	5	Water suitable for livestock.
124.5	129.5	20	Shale	Dark gray	Blocky, silty	None	Drills easily.

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